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Deposition of Air Pollutants to the Great Waters

Second Report to Congress

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EXECUTIVE SUMMARY

This report is the Second Report to Congress on the atmospheric deposition of pollutants to the Great Waters. Section 112 of the Clean Air Act (CAA) provides the legislative basis for hazardous air pollutant (HAP) programs directed by the U.S. Environmental Protection Agency (EPA). In response to mounting evidence that air pollution contributes to water pollution, Congress included section 112(m), *Atmospheric Deposition to Great Lakes and Coastal Waters*, in the 1990 CAA. Under this statute, EPA is required to periodically report to Congress on the results of this program. Concurrent with the Second Report to Congress, EPA is to determine the adequacy of section 112 to prevent adverse effects to public health and serious or widespread environmental effects associated with atmospheric deposition of HAPs to the Great Waters.

How does this report differ from the 1994 Report to Congress?

The First Report to Congress presented information about the health and environmental effects associated with the pollutants of concern, relative atmospheric loadings, and the potential sources of these loadings. The current report documents findings since the First Report to Congress and describes recent progress in these issues. This report places emphasis on local and federal activities, including many that support section 112(m) directives, taking place at specific waterbodies such as the Great Lakes, Lake Champlain, and Chesapeake Bay, as well as coastal estuaries designated through the National Estuary Program and National Estuarine Research Reserve System. Due to the short time period since the First Report to Congress, much of the research data collected during this time are still in the process of being analyzed; however, the objectives and status of these efforts are described in the report. Furthermore, this report does not assess the linkage between the potential sources, loadings, and effects of pollutants of concern because, as in the First Report to Congress, the scientific information is currently not sufficiently complete. As such, unanswered questions still remain as well as uncertainties for some issues. This report proposes a number of future directions to reduce uncertainty in several areas.

Because this report is an update of the First Report to Congress, the information presented here cannot be used alone to develop recommendations regarding atmospheric deposition of pollutants to the Great Waters. Rather, the scientific information summarized in this report, together with the findings and recommendation identified in the First Report to Congress, can be used to assess the extent of progress as a result of recommendations from the First Report to Congress and to determine what gaps in information still exist.

Has the list of Great Waters pollutants of concern changed?

The pollutants of concern to the Great Waters have not changed since the First Report to Congress. The list consists of 15 pollutants (see sidebar on next page) including pesticides, metal compounds, chlorinated organic compounds, and nitrogen compounds. These pollutants have been selected based on information regarding their health and environmental effects and evidence that they are atmospherically deposited to the Great Waters. Most are bioaccumulative chemicals that persist in the environment for long periods. Many of these pollutants are listed as chemicals of concern on toxics lists for individual waterbodies at the local and statewide level.

What are the environmental and public health effects of the pollutants of concern to the Great Waters?

Recent scientific information confirms adverse effects data presented in the First Report. The pollutants are associated with deleterious effects on many target organs in humans and animals, including the liver, kidney, nervous system, endocrine system, reproductive organs, and immunological system. Few new developments have occurred in this area, although there is a growing interest about the potential for some pollutants to act on and disrupt the endocrine system in wildlife and possibly in humans.

The 15 Great Waters Pollutants of Concern

Cadmium and cadmium compounds
Chlordane
DDT/DDE
Dieldrin
Hexachlorobenzene (HCB)
α-Hexachlorocyclohexane (α-HCH)
Lindane (γ-hexachlorocyclohexane; γ-HCH)
Lead and lead compounds
Mercury and mercury compounds
Polychlorinated biphenyls (PCBs)
Polycyclic organic matter (POM)
Tetrachlorodibenzo-p-dioxin (TCDD; dioxins)
Tetrachlorodibenzofuran (TCDF; furans)
Toxaphene
Nitrogen compounds

As in the First Report to Congress, the contribution of atmospheric deposition of the pollutants and subsequent exposure to potential human health and ecological effects cannot be quantified at this time. Pollutants deposited from the air directly into a waterbody may have routes of exposure to aquatic life that differ from exposure by waterborne inputs; however, there are few studies available to address this issue. There is currently no information to suggest that effects produced by pollutants deposited from the air will be different from effects by these pollutants carried in water or found in sediment. Contamination in fish can enter the diet of humans and other animals and, therefore, fish-eating birds or mammals are especially at risk from pollutants that biomagnify because they are exposed to concentrated levels of these pollutants. Evaluation of potential human health effects of pollutants of concern is based almost completely on laboratory studies in animals. The data from these studies may be extrapolated to assess potential adverse effects in humans; however, uncertainties may exist as to the exposure levels at which these potential effects may occur. Atmospheric deposition of nitrogen compounds can contribute significantly to eutrophication in coastal waters, where plant productivity is usually limited by nitrogen availability. Accelerated eutrophication and its subsequent effects such as nuisance algal blooms and reduced oxygen levels pose significant problems for Chesapeake Bay and many other estuaries.

Do water quality exceedances or fish advisories continue to occur as a result of pollution loadings to the Great Waters?

Current water quality criteria exceedances and fish advisories suggest that toxic contamination by persistent toxics is present in the Great Waters. The contribution of atmospheric deposition to the water quality exceedances and contaminant levels in fish is not known at this time. More information on relative loadings of pollutants is needed to assess the extent of contamination attributed to atmosphere.

Water quality criteria have been developed specifically for the Great Lakes, and exceedances of these criteria continue to occur. Recent information is available for some pollutants, and in general, these exceedances have declined in recent years. Fish advisories that are issued by states for individual pollutants provide qualitative information about potential exposure and the extent of

contamination in a waterbody. PCBs are most commonly the focus of fish advisories issued in the Great Waters and their basins, with dioxins having the next highest occurrence of advisories. Elevated levels in fish of other pollutants, such as chlordane and mercury, also have warranted fish advisories in many states around the Great Waters.

What is currently known about the atmospheric deposition of the pollutants of concern to the Great Waters?

The contribution of atmospheric deposition to overall pollutant loadings in the Great Waters continues to be studied. Atmospheric loadings of pollutants result from wet deposition and dry particle deposition and through air-water gas exchange. Described in this report are monitoring and modeling studies relevant to atmospheric deposition that are currently taking place at the major waterbodies of the Great Waters.

Recent atmospheric monitoring data from a binational monitoring network assessing trends of atmospheric deposition to the Great Lakes region indicate that atmospheric levels of toxic pollutants are declining slightly or leveling off and remain a significant concern in the Great Lakes. Several recent activities in the Great Lakes have been initiated to characterize and reduce toxic contamination and deposition to these waters. In the Lake Champlain basin, research on atmospheric loading of mercury is currently underway in the basin. Early data show that atmospheric mercury levels and deposition are comparable to those measured around the Great Lakes.

Nitrogen and toxic contaminants are a concern in Chesapeake Bay and other coastal waters. Excessive nitrogen loading can accelerate eutrophication and its adverse effects, such as nuisance algal blooms and fish kills. Substantial progress has been made in addressing nitrogen contamination issues in Chesapeake Bay, the largest U.S. estuary. A strategy has been developed by the Chesapeake Bay Program for reducing the nitrogen load to the Bay. Part of this process includes the large-scale modeling and understanding of the type and geographic origin of airborne nitrogen to the Bay. Significant data also have been collected on rates and amounts of nitrogen deposition (including comparison of direct and indirect deposition and of wet and dry deposition), and models have been developed to evaluate the impact of several nitrogen reduction scenarios on the Bay's water quality.

Since the First Report to Congress, studies of other coastal waters, at National Estuary Program waters in particular, have investigated the significance of atmospheric deposition of nitrogen compounds to their waters. To improve understanding and reduction of nitrogen deposition to Chesapeake Bay and other coastal waters, the Chesapeake Bay Program, various National Estuary Programs, and the Gulf of Mexico Program continue to develop and refine modeling and monitoring efforts by addressing uncertainties such as nitrogen retention in watersheds, the differences in transport and fate of various nitrogen compounds, and the contribution of nearshore ocean waters to the nitrogen inputs to estuaries.

What is currently known about the sources of atmospheric pollutant deposition to the Great Waters?

Both local and long-range emission sources contribute to atmospheric deposition in the Great Waters. Emission inventories on specific sources of the pollutants of concern are actively

being developed and efforts to gather more information on the potential sources of contamination continue. For example, EPA recently completed a national emissions inventory of known U.S. sources of seven hazardous pollutants of concern listed under CAA section 112(c)(6). Identification of the sources for total emissions of these pollutants is leading to an evaluation of the stationary, anthropogenic source categories to determine whether they are currently regulated or scheduled for regulation under the CAA. Some persistent pollutants are no longer produced through human activities but may continue to affect the Great Waters environment through releases from existing equipment and repeated cycling between the atmosphere, land, and waterbodies.

Understanding atmospheric processes is necessary for analyzing the relationships between source emissions, relative loadings, and the potential for adverse effects in humans and the environment. Because it is often difficult to establish these relationships clearly and quantitatively through available measurement data (e.g., it can be difficult to differentiate between the contribution of distant versus local sources to the loading of a pollutant to a particular waterbody), investigators frequently use mathematical models of atmospheric transport and deposition. This report presents the application of several atmospheric transport and deposition models to the Great Waters and how these models compared to actual data from the waterbodies. Extensive modeling of nitrate emissions and transport that can deposit to Chesapeake Bay has calculated the "airshed" of distant as well as local sources.

What are EPA's current conclusions from this Second Report to Congress?

The information presented in this report advances scientific knowledge on issues related to atmospheric deposition of pollutants to the Great Waters and confirms the findings and conclusions presented in the First Report to Congress. In general, concentrations of some persistent pollutants in the Great Lakes, as monitored by sample measurements of contaminant levels in the air, water, and biota, appear to have leveled off or declined only slightly in recent years.

EPA also has issued draft determinations that the provisions of CAA section 112 are adequate to prevent serious adverse human health effects and serious or widespread environmental effects as a result of atmospheric deposition of HAPs emitted by domestic stationary sources. At this time, EPA believes that there is no information to suggest that additional regulations beyond those authorized or required by section 112 are necessary or appropriate to prevent such effects. The draft determinations will be issued for public notice and comment by June 30, 1997, and final determinations will be made by March 15, 1998.

What future directions may be taken by EPA to support section 112(m)?

Described throughout the report are activities that have increased our knowledge of atmospheric deposition of pollutants to the Great Waters. As new information becomes available on atmospheric pollutant deposition to the Great Waters, additional questions or issues are expected to arise that will require further investigation or action. At this time, EPA has identified the following areas where information is limited and some specific steps that need to be taken to advance our understanding of issues relevant to the Great Waters program:

- Define and proceed with management and regulatory actions for Great Waters pollutants of concern, with a particular focus given to pollutants currently being emitted to the air from sources that can be subject to regulations under the CAA (for example, the seven pollutants of concern in section 112(c)(6));

- Continue to support monitoring and research efforts on deposition to make informed management decisions and to track reductions;

- Perform exposure and effects studies that will build on the recent Great Lakes Water Quality Criteria, which consider biomagnification. These studies will be coordinated with an integrated research strategy on the persistent pollutants, their distribution and concentrations, exposure routes, and associated effects;

- Improve modeling efforts to estimate atmospheric loadings to Great Waters. For example, adapt and apply the comprehensive approach developed for the Lake Michigan Mass Balance Model to additional waterbodies;

- Increase efforts to identify specific emissions sources of atmospheric deposition to the Great Waters, both nearby and relatively distant from the waterbody, to develop risk management strategies, as well as investigate the impact from cycling of pollutants that are no longer used or manufactured in the United States;

- Continue to promote pollution reduction in the Great Waters through local, regional, and federal initiatives, as well as coordinated international efforts; and

- Assess economic costs and benefits associated with reductions of pollutants to the Great Waters, including identifying and quantifying, where possible, economic impacts associated with exposure and effects indicators such as fish advisories, habitat decline, diminished species diversity, fish kills, and declining or contaminated shellfish and fish populations.

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LIST OF ABBREVIATIONS AND ACRONYMS

Ah	Aryl hydrocarbon
AOC	Area of Concern
AQSM	Air quality simulation model
ATSDR	Agency for Toxic Substances and Disease Registry
AWQC	Ambient water quality criterion or criteria
B(a)P	Benzo(a)pyrene
CAA	Clean Air Act
CBADS	Chesapeake Bay Atmospheric Deposition Study
CBOS	Chesapeake Bay Observing System
CBP	Chesapeake Bay Program
CCMP	Comprehensive Conservation and Management Plan
CMB	Chemical mass balance
CWA	Clean Water Act
DDD	Dichlorodiphenyldichloroethane
DDE	Dichlorodiphenyldichloroethylene
DDT	Dichlorodiphenyltrichloroethane
DES	Diethylstilbestrol
dL	Deciliter
EMAP	Environmental Monitoring and Assessment Program
EPA	U.S. Environmental Protection Agency
FDA	Food and Drug Administration
g	Gram
GLWQA	Great Lakes Water Quality Agreement
GLWQB	Great Lakes Water Quality Board
GLWQC	Great Lakes Water Quality Criteria
GLWQG	Great Lakes Water Quality Guidance
GLWQO	Great Lakes Water Quality Objective
GMP	Gulf of Mexico Program
HAP	Hazardous air pollutant
HCB	Hexachlorobenzene
α-HCH, γ-HCH	alpha-Hexachlorocyclohexane, gamma-Hexachlorocyclohexane
Hg	Mercury
IADN	Integrated Atmospheric Deposition Network
IJC	International Joint Commission
kg	Kilogram
km, km^2, km^3	Kilometer, square kilometer, cubic kilometer
L	Liter
LaMP	Lakewide Management Plan
LCBP	Lake Champlain Basin Program
LMUATS	Lake Michigan urban air toxics study
LQER	Lesser-quantity emission rates
MACT	Maximum achievable control technology
MCL	Maximum contaminant level
m^2, m^3	Square meter, cubic meter
μg, ug	Microgram
mg	Milligram
NAAQS	National ambient air quality standard
NADP	National Atmospheric Deposition Program
NAPAP	National Acid Precipitation Assessment Program
NEP	National Estuary Program
NERRS	National Estuarine Research Reserve System
ng	Nanogram

LIST OF ABBREVIATIONS AND ACRONYMS
(continued)

NOAA	National Oceanic and Atmospheric Administration
NO_x	Oxides of nitrogen
NS&T	National Status and Trends
OAQPS	Office of Air Quality Planning and Standards
OTC	Ozone Transport Commission
PAH	Polycyclic aromatic hydrocarbon
PCA	Principal component analysis
PCB	Polychlorinated biphenyl
pGLWQC	Proposed Great Lakes water quality criteria
POM	Polycyclic organic matter
ppb, ppm	Parts per billion, parts per million
RADM	Regional Acid Deposition Model
RAP	Remedial Action Plan
RAPIDS	Regional Air Pollutant Inventory Development System
RELMAP	Regional Lagrangian Model of Air Pollution
REMSAD	Regional Modeling System for Aerosols and Atmospheric Deposition
RPM	Regional Particulate Model
SAB	Science Advisory Board
SAV	Submerged aquatic vegetation
SETAC	Society of Environmental Toxicology and Chemistry
SOLEC	State of the Lakes Ecosystem Conference
TBADS	Tampa Bay Atmospheric Deposition Study
TCDD	Tetrachlorodibenzo-p-dioxin
TCDF	Tetrachlorodibenzofuran
TRIADS	Texas Integrated Atmospheric Deposition Study
TSCA	Toxic Substances Control Act
VOC	Volatile organic compound
yr	Year